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PERFORMANCE BASED TESTING IN USE AT RUSSIAN FACILITIES FOR SYSTEM IMPROVEMENT AND OPERATIONS ASSURANCE

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(Note: This paper will also be published in the proceedings of the Institute of Nuclear Materials Management)

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ABSTRACT

Integration of MPC&A systems at Russian facilities has moved beyond the project end dates and the systems have been operational for some time at a number of Russian sites. At some of these sites, system of performance testing is resulting in data that is being analyzed to determine the health and operability of the system. Naturally, as the systems are young, a number of operational problems are being discovered and solved by Russian scientists and technicians. This paper explains the performance testing program including the types of systems being analyzed. It also discusses the tools and process used to analyze the data and the actions taken. It will discuss the organizations that support this activity and their success in establishing this function at the referenced sites.

INTRODUCTION

The objective of the U.S. Department of Energy (DOE) Material Protection, Control, and Accounting (MPC&A) Program is to reduce the threat of nuclear proliferation by cooperating with the Russian government to improve MPC&A and to establish a sustainable infrastructure providing future support for these technology-based improvements. Cooperation with Russia under the MPC&A Program has included aggressive near-term activities to better secure nuclear materials through MPC&A system upgrades. Facilities are being upgraded, equipment procured and installed, and personnel trained. At the same time, the program is helping Russia achieve its long-term goal of implementing upgraded MPC&A systems that can be maintained and supported from indigenous resources.

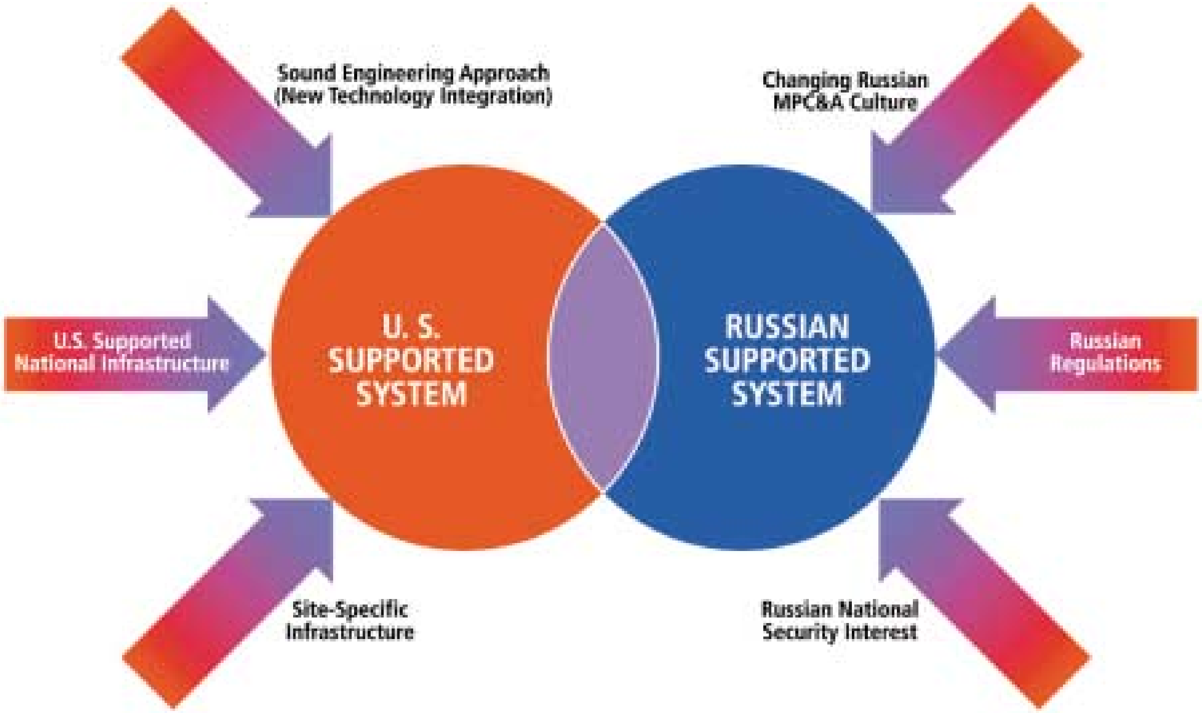
Physical protection and material control and accounting equipment operability is essential to the MPC&A mission. Reducing false and nuisance alarm rates and discovering the root cause for system failures are important program goals. This paper describes interactions between specialists on the US and Russian sides who began discussing program direction pertaining to long term system operations including Statistical Process Control (SPC) tools for the optimization of Russian MPC&A system performance. The paper then describes the implementation of these tools at a specific Russian facility, the Moscow State Engineering Physics Institute (MEPhI).

US/RUSSIAN TECHNICAL EXCHANGE

In August 2000, program managers from the National Programs Division, Site Operations and Sustainability project invited a specialist from the MEPhI facility for an extended stay at the non-proliferation program office in Oak Ridge, TN. The purpose of this internship was to familiarize that individual with of MPC&A operations program philosophy. The internship lasted for one month and allowed for intensive and reinforcing discussions between the specialists about key program ideas. This internship was completely successful in meeting its designed objective: to share a common vision of the MPC&A program operational objectives.

During the visit in Oak Ridge, intensive time was spent in short, focused, daily technical exchange sessions that were free of official obligations. Successive days of these sessions for weeks allowed for complete understanding by both parties of the other's ideas. Each side had an opportunity to discuss, formulate questions and re-enforce at the next session.

Discussions focussed on the need for the US side to explain to the Russian side the guidance and motivators for programmatic activity in Russia. During these discussions, the US side learned that the Russians perceive two distinct MPC&A systems: one system that is important to the US and its objectives and the other that is important to the Russian side. An illustration of this point can be seen in the following figure.



This program vision introduced a different and useful model for evaluation of system effectiveness. The "US Supported System" area, presented in red, depicts the system that is integrated at the site that is there for the exclusive purpose of serving US goals. The "Russian Supported System" area, similarly is the existing or "old" system that depicts the system that supports Russian needs exclusively. The overlap represents system elements of common purpose and interest. The implications for the long-term operation of the program are clear. If the US removes funding for operations of system components that it alone finds important, the Russian side will not fund these elements and that part of the system will cease to function. The long-term operability goals therefore, should include finding and enhancing the forces that tend to maximize overlap. These forces include: effective technology integration from the outset; providing site level infrastructure elements that support the operating system, understanding what is supported by the Russian regulatory base; National Russian infrastructure issues and other factors. It is conceivable that technology is so effectively integrated as to provide 100 percent overlap and the system will be inherently stable from its initial operation: these cases are rare indeed. It is also conceivable that systems are installed that have no impact on site operations and represent radically new business processes that are not accepted and have no overlap. These are fortunately rare as well, but situations approaching these are the motivator for the MPC&A operations program.

This concept, as depicted in the diagram, has become a cornerstone of the MPC&A operations program. The discussion also focused on specific process improvement tools that were in use and are being disseminated to Russian sites. The remainder of this paper discusses this topic.

SPECIFIC TOOLS USED FOR SYSTEM IMPROVEMENT AT MEPHI

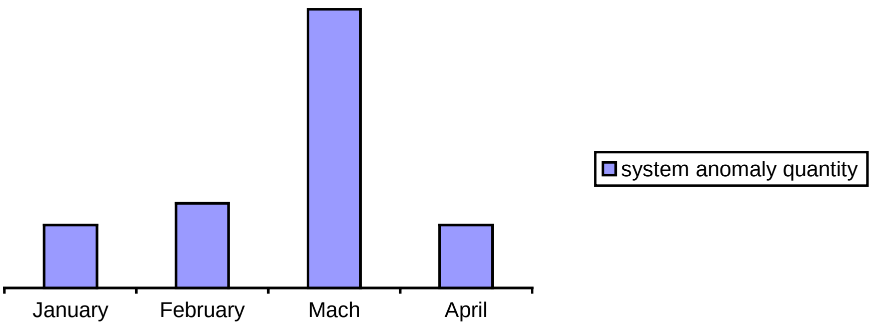
In 1998 a physical protection system was created at the Moscow State Engineering Physics Institute (MEPhI) in order to protect the buildings, where nuclear materials are handled (the IRT research reactor itself, the training building and storage facility of nuclear material and sources). There is an internal area and a special important area at the facility. The MEPhI physical protection system (PPS) includes:

- An external perimeter;
- An access control system;
- A video monitoring system.

The PPS is based on HIRSCH controllers. Information about all events in the system is recorded and stored in the archives of the computerized PPS. Thus, it is possible to obtain data about the system operation, which is necessary for the quality control.

A number of MEPhI employees have been selected as the personnel to work on system operations and maintenance. These personnel also work on quality control of system operation. The PPS operation and maintenance personnel have been trained accordingly. For the system operation quality control MEPhI uses methods of statistical process control (SPC).

The first example of the use of SPC for the quality control at MEPhI is the event distribution diagrams as a function of time. A simple example is shown below. It is advisable to draw a distribution diagram (statistical picture) like this for a year or a month. By the analysis of the



statistical picture of the system and comparison with the diagrams of other events at the site (natural phenomena, voltage spikes, certain technological processes) it is possible to determine reasons for system operation deficiencies.

Another example of statistical analysis is the chart of average values or the control of anomaly quantity in the system. In this case the average value of the system anomalies/failures during a specified period of time is calculated, as is the standard deviation for the calculated average value. This traditional "control chart" plots a statistical signature for the operation of the system and allows administrators to determine if the system is in control or running out of control. Points outside of the calculated standard deviation are investigated for cause and these problems are corrected. If a general trend of the operation of the system is going out of control, action can be taken before the consequences are serious.

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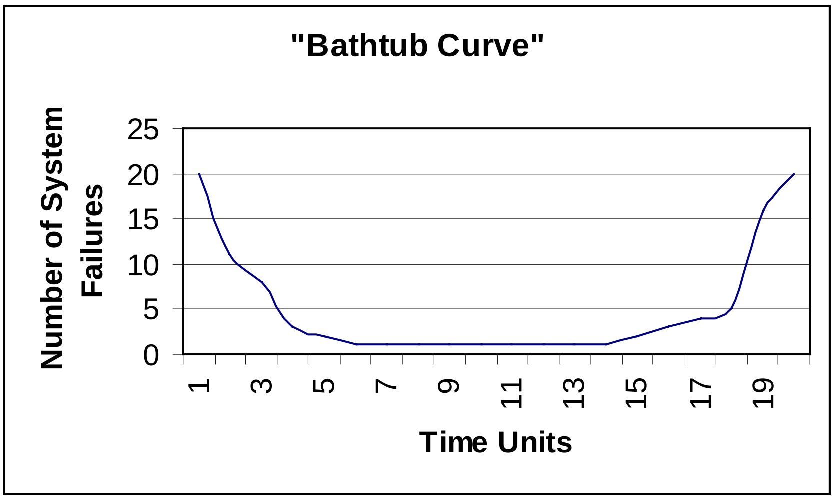
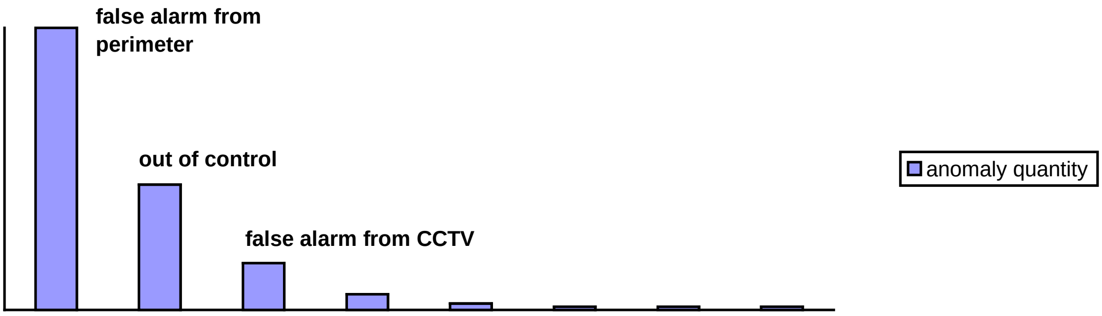
The diagram of system anomaly/failure distribution as a function of time allows calculating the trend/tendency of the system. In terms of the total number of anomalies in the system we can judge that the MEPhI PPS has reached the normal operation level. At the normal operation level, additional tools can be applied to further improve operations.

It is often desirable to take into account the natural life cycle of system components. This data comes from months or years of recording failure rates of system components in a maintenance system. Typically, the failure rate is quite high when the component is new (the “burn in” stage) and again increases as the component nears the end of its life. A plot of this data results in a characteristic "bathtub” shaped curve. After doing this analysis, a site can determine where an equipment component is in its life cycle and predict failure. This information can be used for spare parts allocation or the determination of replacement schedules.



The next example or the method of system operation data analysis is the use of the distribution diagram of anomalies/failures in the system. An example of this analysis is shown in the figure below.



A diagram of this type (also known as a Pareto analysis) allows system administrative and maintenance staff to focus on the first three anomalies in the system. This approach allows for judicious application of scarce resources. Anomalies from the first three sources provide maximum contribution to the total number of anomalies/failures in the system. Focusing work and solving the problems identified in the first three causes resulted in a drastic reduction in their contribution to total failure. At this point, a new diagram is drawn and the new top three contributors to total failure are again analyzed. This process is repeated and the system is continuously improved.

The use of techniques of statistical analysis at MEPhI resulted in a positive effect. It is not expedient to report about specific examples, as every site has its own unique problems. It is also necessary to note that the exchange of experience on the base of results of PPS operation at different sites is essential and useful. The results of the statistical analysis of system operation are most representative in the experience exchange. The warranty for the PPS equipment at MEPhI has expired; hence it is essential to use the funds and efforts on the operational maintenance of the PPS in areas that will have the most beneficial effect.

NEW EFFORTS IN OPERATIONAL IMPROVEMENT AT MEPHI

Under the auspices of the intergovernmental cooperation between the USA and Russia in the field of MPC&A, in 2000 MEPhI was selected as a participant of a comprehensive program, aimed at the improvement of the MPC&A systems in both countries. Currently the efforts of the program are aimed at solving the stability problems of the MPC&A systems, both developed and being developed, at Russian sites.

The goal of work is to accumulate experience and devise solutions for problems, thus improving system operability. One of the proposed options of quality control for the MEPhI MPC&A system was the identification and documentation of critical processes. This approach enabled fast checking of the status and conditions at MEPhI on all operations that require special attention. The goal of that work is to check the ability of all MPC&A system components to function so that it could provide an appropriate protection of all sensitive processes at the site and exercise control over operations pertaining to MPC&A. The proposed technical approach has shown the ways to use the documentation on critical processes as a basis for operations, training, performance testing, and for a confirmation of the need to upgrade or modify the present MPC&A system.

SUMMARY

Through continued cooperation in the operational phase a problem solving posture can be established. Many opportunities exist for technical exchange including the traditional phone, email, videoconferences and international publications. There is however, no substitute for intense face-to-face exchange and cooperative study for long periods of time. The model presented in this paper should be imitated to continue the good work. The paper also shows some of the specific subject area in system improvement that is important for continuing operational evaluation. The tools presented here represent yet another vocabulary set that supports technical exchange necessary to support continued US/Russian cooperation, problem solving and long term system effectiveness.